

Quality of Surface Water in New Jersey, Water Years 2007 and 2008

Introduction

The U.S. Geological Survey (USGS), in cooperation with Federal, State, and local agencies, collects a large amount of data pertaining to the water resources of New Jersey each water year (WY—October 1 to September 30). These data are stored and maintained in the National Water Information System database (NWIS) and constitute a valuable source of reliable, impartial, and timely information for developing an improved understanding of the water resources of the State. To make this information readily available, the data were published annually from WY 1961 to WY 2005 in the report series, titled “Water Resources Data-New Jersey.” Additionally, data from WY 2002 through WY 2005 are available in electronic form as PDF files of individual, or groups of, stations. Data from WY 2006 through WY 2008 are available as individual electronic Site Data Sheets. Both forms of current and archival electronic data can be accessed through the World Wide Web at <http://wdr.water.usgs.gov>. The water-quality volumes of the WY 2007 and WY 2008 annual data reports consist of analytical results of multiple samples from 182 surface-water stations and single samples from 47 bed-sediment and 59 groundwater stations and can also be accessed through the USGS-NJ Water Science Center at <http://nj.usgs.gov/adr/adr2007/WDR-NJ-07-3/> and <http://nj.usgs.gov/adr/adr2008/WDR-NJ-08-3/>. These volumes include a detailed cross-referenced index of stations.

Data on the physical characteristics of some streams are available in real time. Continuous records of water temperature, specific conductance, pH, dissolved oxygen (DO) concentration, DO percent of saturation, or turbidity for stations 01388000, Ramapo River at Pompton Lakes NJ, downstream of dam; 01389005, Passaic River below Pompton River at Two Bridges NJ; 01400500, Raritan River at Manville; 01408029, Manasquan River at Allenwood; 01463500, Delaware River at Trenton NJ; and 01467029, Delaware River diversion at Delran are not summarized in this report but are available at <http://waterdata.usgs.gov/nj/nwis/current/?type=quality>. Not all constituents are measured at each station. These records consist of real-time hourly values for the most recent 60-day period and daily values (maximum, minimum, and mean) for the period of record.

In WY 2007, studies were conducted during base-flow conditions to measure the 24-hour variability of continuously monitored DO concentration, DO percent of saturation, specific conductance, water temperature, and pH at two network stations and eight special-study sites, and in WY 2008, at one network station and seven special-study sites. The sites monitored during 2007 were 01378500, Hackensack River at New Milford; 01390510, Saddle River at Ridgewood Avenue at Ridgewood;

01391200, Saddle River at Fairlawn; 01407026, Wilkson Creek at Church Street at Matawan; 0140802850, Manasquan River at Golf Course Bridge near Allenwood; 01411466, Indian Branch near Malaga (in-network); 01411500, Maurice River at Norma (in-network); 01463568, Assunpink Creek at Carson’s Mill; 01463661, Shipetaukin Creek near Lawrenceville, and 01464380, North Run at Cookstown. The sites monitored during WY 2008 were 01390518, Saddle River at Grove Street at Ridgewood; 01390700, Hohokus Brook at Wyckoff; 01391100, Hohokus Brook at mouth at Paramus; 01391200, Saddle River at Fairlawn; 01391500, Saddle River at Lodi (in-network); 01391540, Saddle River at Felician College at Lodi; 01482519, Salem River at Main Street at Sharptown; and 01482530, Major Run at Sharptown. Site selection was based on previous occurrence of DO super-saturation (greater than 120 percent of saturation), DO under-saturation (less than 60 percent of saturation), or exceedance of New Jersey surface-water-quality standards. In-situ multi-constituent water-quality monitors measured the occurrence and magnitude of diurnal variations not observed when instantaneous samples were collected during sampling visits (generally between the hours of 8 a.m. and 2 p.m.). The monitors were deployed for 1 or 2 periods during July to September with each period lasting 5 to 7 days. The data are not summarized in this report but can be accessed in tabular form at http://nj.usgs.gov/qw/diurnal_do/ and in graphical form in the annual data reports.

The purpose of this report is to summarize selected ambient surface-water-quality data collected cooperatively by the USGS and New Jersey Department of Environmental Protection (NJDEP) during WY 2007 and WY 2008. Data on the physical characteristics and (or) water-quality constituents in samples collected at 110 surface-water and 47 bed-sediment stations are presented in figures and tables.

Ambient Surface-Water-Quality Monitoring Network

The USGS and NJDEP operate the cooperative Ambient Surface-Water-Quality Monitoring Network (ASWQMN)—a collection of monitoring stations on streams throughout New Jersey. Constituent concentration data from the ASWQMN are used to determine statewide water-quality status and trends, define the water quality of streams near the downstream end of each NJDEP Watershed Management Area (WMA), define background water quality in each of the four physiographic provinces of New Jersey, and define water quality in streams that drain targeted land-use areas. The ASWQMN consists of as many as 115 stations located throughout the 20 WMAs (fig. 1). Seven background stations are located on reaches of streams that remain relatively unaffected by human activity; data from

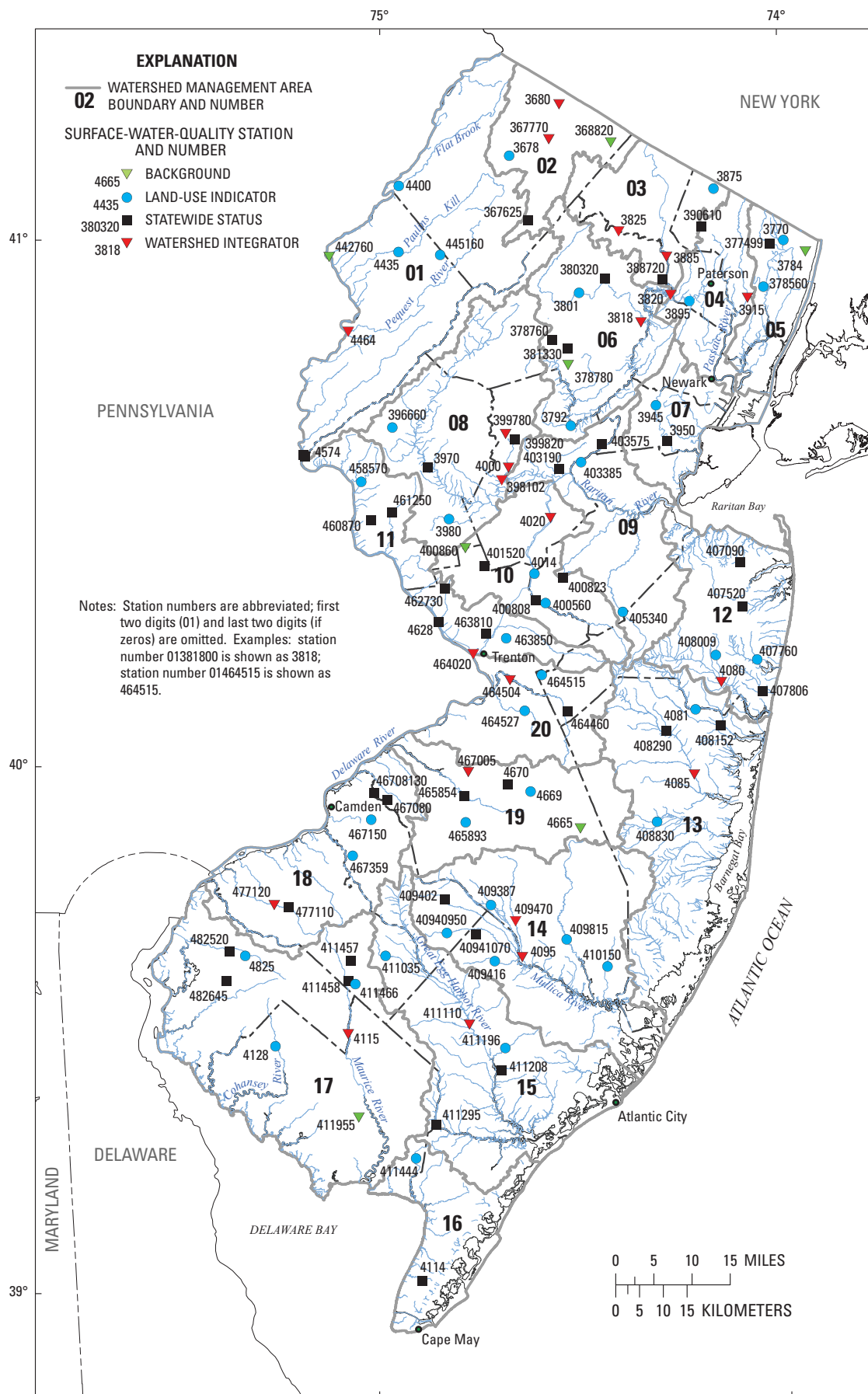


Figure 1. Location and type of stations in the Ambient Surface-Water-Quality Monitoring Network, water years 2007 and 2008.

these stations are used to develop a water-quality database consisting of baseline measurements. Twenty-three Watershed Integrator (WI) stations are located near the farthest downstream point, not affected by tide, in one of the large drainage basins in each WMA, except WMAs 5, 9, and 16 because of the effects of tides, lack of suitable sites, and limited basin size, respectively. The WI stations provide water-quality data for large drainage areas that integrate the effects of different types of land use on, and point and nonpoint contributions of constituents to, the water quality of streams within each WMA. Land Use Indicator (LUI) stations are used to monitor the effects of the dominant land use in each WMA and provide data on nonpoint source loading of contaminants to streams. Of the 43 LUI stations, 15 are designated undeveloped; 9, agriculture; 13, urban; and 6, mixed. Forty-two statewide status (SS) stations are chosen randomly to obtain a statistical basis that can be used to estimate values of water-quality indicators statewide. SS stations are selected on a bi-annual basis and are sampled during two consecutive years. In WY 2007 and WY 2008, five of the SS stations were sited at existing WI or LUI stations, reducing the total number of stations sampled to 110. Data from four additional stations on the Delaware River, the border between New Jersey and Pennsylvania, are not summarized in this report but are available in the annual data reports.

Laboratory Reporting Conventions

The analyzing laboratories use two different methods and reporting conventions to establish the minimum concentration above which a quantitative measurement can be made. These reporting conventions are the minimum reporting level (MRL) and the laboratory reporting level (LRL). The MRL, used infrequently with certain methods, is defined by the National Water Quality Laboratory (NWQL) as the smallest concentration of a substance that can be reliably measured using a given analytical method. The LRL, used frequently with most methods, generally is equal to twice the yearly determined long-term method detection level (LT-MDL). The LT-MDL is a detection level derived by determining the standard deviation of a minimum of 24 method detection limit spike-sample measurements over an extended period of time. The LT-MDL controls false positive error; the probability of falsely reporting a concentration at or greater than the LT-MDL for a sample that did not contain an analyte is predicted to be less than or equal to 1 percent. The LRL controls false negative error; the probability of falsely reporting a non-detection for a sample that contained an analyte at a concentration equal to or greater than the LRL is predicted to be less than or equal to 1 percent. Analytes detected at concentrations between the LT-MDL and the LRL, and that pass identification criteria, are “estimated” (noted with a remark code of E). The value of the LRL is reported with a “less than” (<) remark code for samples in which the analyte is not detected.

Data Analysis Methods

The distribution of selected constituent data is graphically displayed using side-by-side box plots. The plots show

the median [midpoint of the data (50th percentile)—the center line of the box], the variation [interquartile range (25th to 75th percentiles)—the box height], the skewness (quartile skew—the relative size of the box halves), the spread (upper and lower adjacent values—vertical lines or whiskers), and the presence or absence of unusual values or outliers (individual points). If the median equals the 25th and 75th percentiles, the box is represented by a line. For box plots in this report, values reported to be less than the LRL or MRL are included in each distribution as a value equal to the LT-MDL or one-half the MRL, respectively; values reported as “E”—estimated to be greater than the LT-MDL but less than the LRL—also are included. The following constituents had multiple LRLs during the 2-year period: ammonia-plus-organic nitrogen, nitrite-plus-nitrate nitrogen, arsenic, barium, beryllium, cadmium, chromium, nickel, and silver. For these, values reported as less than the lower LRL or estimated between the lower LT-MDL and LRL were corrected to the higher of the two LT-MDLs. For scatter distributions of detected values in this report, values reported as less than the LRL are considered to be not detected and are excluded; values reported as estimated below the LRL are included.

Distribution and Concentration of Selected Constituents from Stations in the ASWQMN

Physical characteristics and concentrations of filtered and unfiltered nutrients, filtered organic carbon, and total dissolved solids (TDS; parameter code 70300, residue upon evaporation) were determined in water samples from 110 stations in the ASWQMN. Samples were collected at each station four times each WY during November to December, February to March, May to June, and August to September. Water temperatures over the 2 years ranged from a low of 0.0 °C to a high of 29.3 °C; both were measured at SS stations (fig. 2). DO in percent of saturation, in the growing season, ranged from 16.0 to 148.3 percent; both were measured at SS stations. Field-determined turbidity ranged from 0.23 nephelometric turbidity ratio units (NTRU) measured at a background station to 306 NTRU at a SS station. TDS concentrations ranged from 17.6 milligrams per liter (mg/L) in a sample collected at a background station to 1,240 mg/L at an urban-LUI station. Ammonia-plus-organic nitrogen concentrations ranged from 0.07 mg/L at several background stations to 4.38 mg/L at a mixed-LUI station. Ammonia as nitrogen (N) concentrations ranged from 0.002 mg/L at several station types to 2.31 mg/L at an agriculture-LUI station. Nitrite-plus-nitrate concentrations ranged from 0.03 mg/L at several station types to 12.8 mg/L at a SS station. Phosphorus concentrations ranged from 0.004 mg/L at several station types to 1.74 mg/L at an urban-LUI station.

The median water temperatures measured during WY 2007 and WY 2008 were similar for all station types, ranging from 11.40 to 12.89 °C. Samples from urban-LUI stations had the lowest median DO (72.7 percent); the highest median turbidity (6.6 NTRU); and the highest median concentrations of TDS (208 mg/L), ammonia-plus-organic nitrogen (0.42 mg/L), ammonia as nitrogen (0.08 mg/L), and phosphorus (0.09 mg/L). Agriculture-LUI stations had the highest median

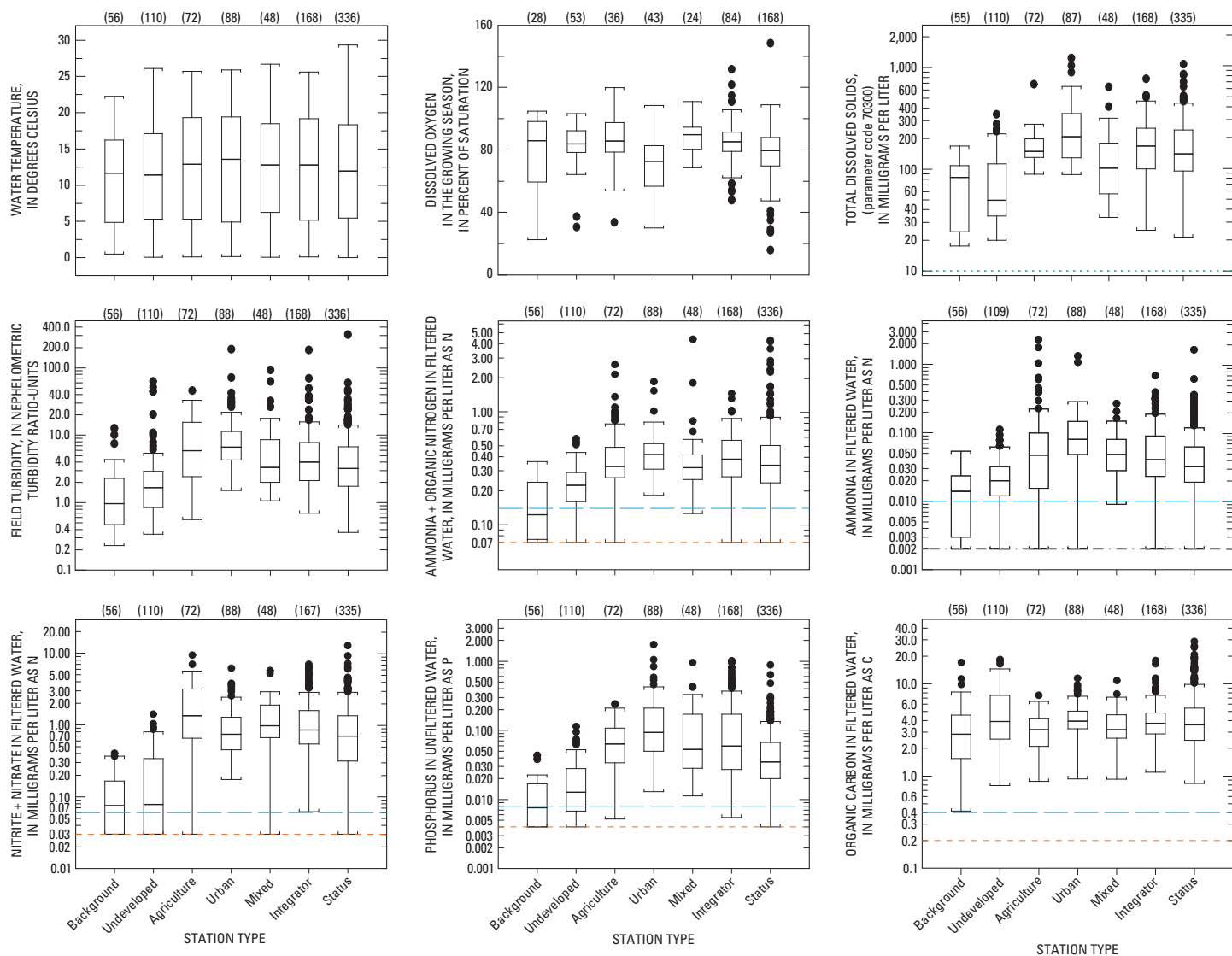


Figure 2. Distribution of selected physical characteristics and concentrations of nutrients in samples from 110 stations in the Ambient Surface-Water-Quality Monitoring Network, in relation to station type, water years 2007 and 2008. [“Less than” values are shown as equal to the long-term method detection level (or one-half the laboratory reporting level).]

concentration of nitrite-plus-nitrate as N (1.35 mg/L). In contrast, samples from background and undeveloped-LUI stations had the lowest median levels of turbidity (0.97 and 1.66 NTU, respectively), and the lowest median concentrations of TDS (83.1 and 49.6 mg/L), ammonia as N (0.014 and 0.020 mg/L), ammonia-plus-organic nitrogen (0.12 and 0.22 mg/L), nitrite-plus-nitrate as N (0.07 and 0.08 mg/L), and phosphorus (0.008 and 0.013 mg/L).

Dissolved organic carbon (DOC) is a heterogeneous mixture of many organic materials, mostly high molecular-weight organic acids, which are the product of biodegradation of organic matter. Organic matter can originate from anthropogenic or natural sources. For example, urban-LUI stations would have DOC associated with human activities and undeveloped-LUI and background stations would have naturally occurring DOC. Concentrations of DOC during WY 2007 and WY 2008 ranged from 0.42 mg/L at a background station to 28.7 mg/L at a SS station. The highest median concentrations of DOC were found in samples from undeveloped and urban LUI stations (3.92 and 3.94 mg/L, respectively).

Distribution and Concentration of Recoverable Trace Elements from Selected Stations in the ASWQMN

Samples for the determination of recoverable trace elements (TEs) in unfiltered water were collected during February to March and August to September of 2007 and 2008 at 7 background and 42 SS stations. Concentrations ranged as follows: arsenic, 0.30 to 22.1 micrograms per liter ($\mu\text{g/L}$); barium, 7.82 to 197 $\mu\text{g/L}$; beryllium, 0.03 to 0.20 $\mu\text{g/L}$; boron, 4.00 to 264 $\mu\text{g/L}$; cadmium, 0.009 to 1.82 $\mu\text{g/L}$; chromium, 0.30 to 6.98 $\mu\text{g/L}$; copper, 0.60 to 12.6 $\mu\text{g/L}$; iron, 7.60 to 6,060 $\mu\text{g/L}$; lead, 0.03 to 7.22 $\mu\text{g/L}$; manganese, 0.94 to 343 $\mu\text{g/L}$; mercury, 0.005 to 0.039 $\mu\text{g/L}$; nickel, 0.18 to 6.32 $\mu\text{g/L}$; selenium, 0.04 to 0.56 $\mu\text{g/L}$; silver, 0.01 to 0.49 $\mu\text{g/L}$; and zinc, 1.00 to 55.1 $\mu\text{g/L}$. The median concentration of each TE was lower in samples from background stations than in samples from SS stations (fig. 3). Of 28 samples from background stations, arsenic, beryllium, chromium, mercury, and silver were found in measureable concentrations (above the LRL) in only 2, 4, 3, 1, and 1 sample(s), respectively. Median concentrations of arsenic, barium, boron, copper, iron, lead, manganese, nickel, and selenium, determined in samples collected at background stations, were less than the 25th percentile concentration of samples from SS stations.

Distribution, Concentration, and Detection Frequency of Pesticides from Selected Stations in the ASWQMN

Samples for the determination of moderate-use pesticides and selected degradates in filtered water (USGS method number O-2002-01) were collected during May and June of 2007 and 2008 at 7 background and 42 SS stations. Three of the 42 SS stations were sampled a second time for a total of 52 samples. Of 83 compounds analyzed for, 24 were detected in at least one sample. Of those 24, 10 had only very low (estimated) concentrations whereas 14 had concentrations greater than their respective LRLs (fig. 4). All 24 compounds were detected in samples from one or more SS stations. The herbicides acetochlor, atrazine, metolachlor, and simazine, and the insecticide

fipronil were the only compounds detected at background stations; concentrations generally were near or less than 0.01 $\mu\text{g/L}$. Atrazine, metolachlor, fipronil, prometon (a herbicide), and simazine were the most frequently detected compounds in 90, 85, 56, 56, and 54 percent of all samples, respectively. Median concentrations generally were near 0.01 $\mu\text{g/L}$. Concentrations of atrazine ranged from 0.004 to 2.18 $\mu\text{g/L}$; concentrations of simazine ranged from 0.004 to 0.086 $\mu\text{g/L}$.

Distribution and Concentration of Nutrients and Recoverable Trace Elements in Bed Sediment from Selected Stations in the ASWQMN

Samples for the determination of selected constituent concentrations in bed sediment are collected at two of the seven background and 20 of the 42 SS stations each water year. In the event SS stations are determined to be unsuitable, other types of stations are substituted. One additional sample in WY 2007 and two in WY 2008 were collected. Samples for the determination of nutrients and TEs in bed sediment were collected under low-flow conditions during August and September of 2007 and 2008 at a combined total of 4 background, 3 WI, 3 undeveloped-LUI, 2 agriculture-LUI, 2 urban-LUI, and 33 SS stations. Ammonia-plus-organic nitrogen, phosphorus, and total carbon were present in all bed sediment samples at high concentrations (fig. 5). Ammonia-plus-organic nitrogen concentrations ranged from 16.4 milligrams per kilogram (mg/kg) in a sample collected at a SS station to 766 mg/kg at an undeveloped-LUI station; phosphorus concentrations ranged from 63.6 at a SS station to 9,800 mg/kg at a WI station; and total carbon concentrations ranged from 526 at a SS station to 26,930 mg/kg at an agriculture-LUI station. Concentrations did not vary appreciably by station type.

Measurable concentrations of several TEs—arsenic, chromium, iron, lead, manganese, and nickel—were found in all samples of bed sediment (fig. 6). Concentrations ranged as follows: arsenic, from 0.11 to 12.8 micrograms per gram ($\mu\text{g/g}$), both at SS stations; chromium, 1.20 to 246 $\mu\text{g/g}$, both at SS stations; iron, 156 to 188,500 $\mu\text{g/g}$, both at SS stations; lead, 2.88 $\mu\text{g/g}$ at a background station to 155 $\mu\text{g/g}$ at an urban-LUI station; manganese, 1.97 $\mu\text{g/g}$ at a SS station to 1,220 $\mu\text{g/g}$ at an agriculture-LUI station; and nickel, 0.29 to 36.4 $\mu\text{g/g}$, both at SS stations. Concentrations less than the MRLs of cadmium, cobalt, copper, mercury, selenium, and zinc were reported in 2, 2, 10, 33, 25, and 4 samples, respectively. Measureable concentrations did not vary appreciably by station type except for the single highest values of mercury (0.352 $\mu\text{g/g}$) and zinc (382 $\mu\text{g/g}$), both at SS stations.

Distribution, Concentration, and Detection Frequency of Organic Compounds in Bed Sediment from Selected Stations in the ASWQMN

Samples for the determination of polycyclic aromatic hydrocarbons (PAHs) and total polychlorinated biphenyls (PCBs) concentrations in bed sediment were collected at the same times and station types noted in the preceding section. Of the 29 PAH compounds analyzed using USGS method number O-5505-03 and total PCBs analyzed using USGS method number O-5504-03, only those with State of New Jersey

surface-water-quality standards—16 compounds—are discussed here. Dibenzo(a,h)anthracene and isophorone are not included in figure 7; they were not detected in any sample. Generally, bed-sediment samples from background and undeveloped-LUI stations had the fewest detections and lowest concentrations; samples from urban-LUI and SS stations had the highest concentrations (fig. 7). With the exception of PCBs (not detected in two samples) and 9H-fluorene (not detected in one sample), each compound was detected in every sample from urban-LUI, agriculture-LUI, and WI stations.

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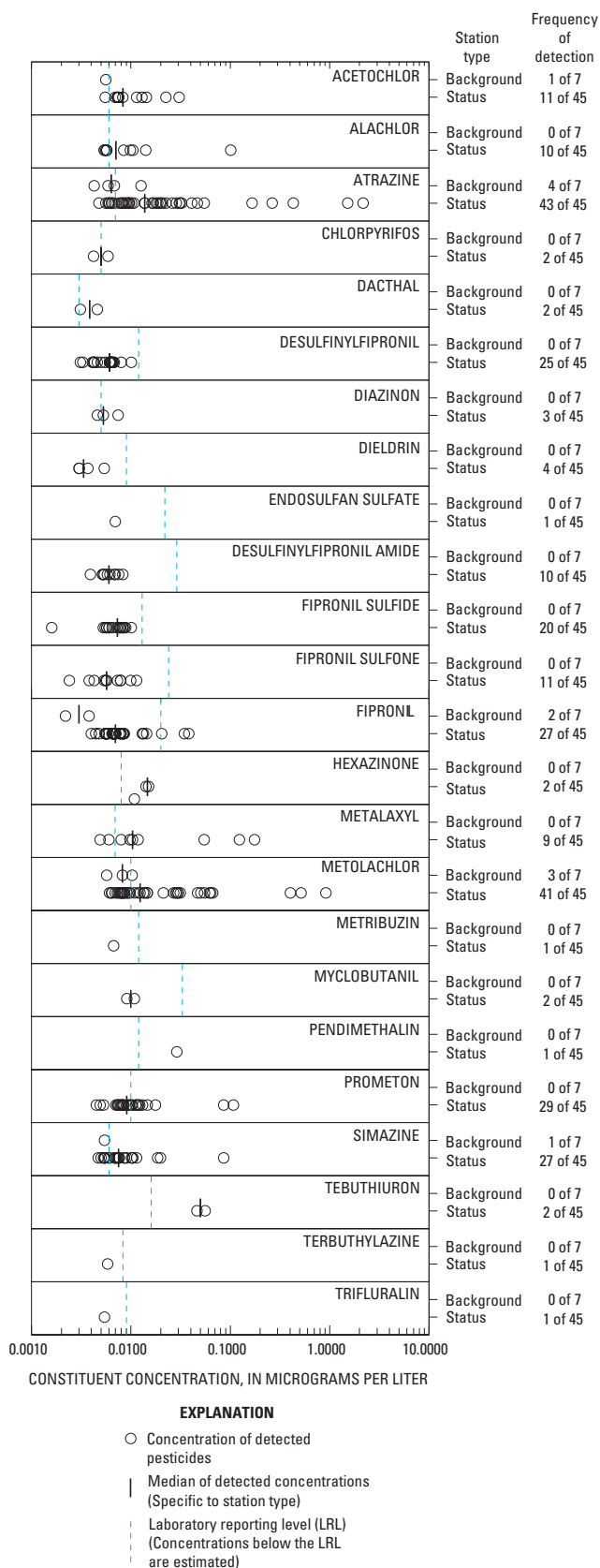


Figure 4. Concentration and detection frequency of selected pesticides detected in filtered samples from 49 stations in the Ambient Surface-Water-Quality Monitoring Network, in relation to station type, water years 2007 and 2008. [Concentrations below the long-term method detection level are considered “not detected” and are excluded. Concentrations below the laboratory reporting level are estimated.]

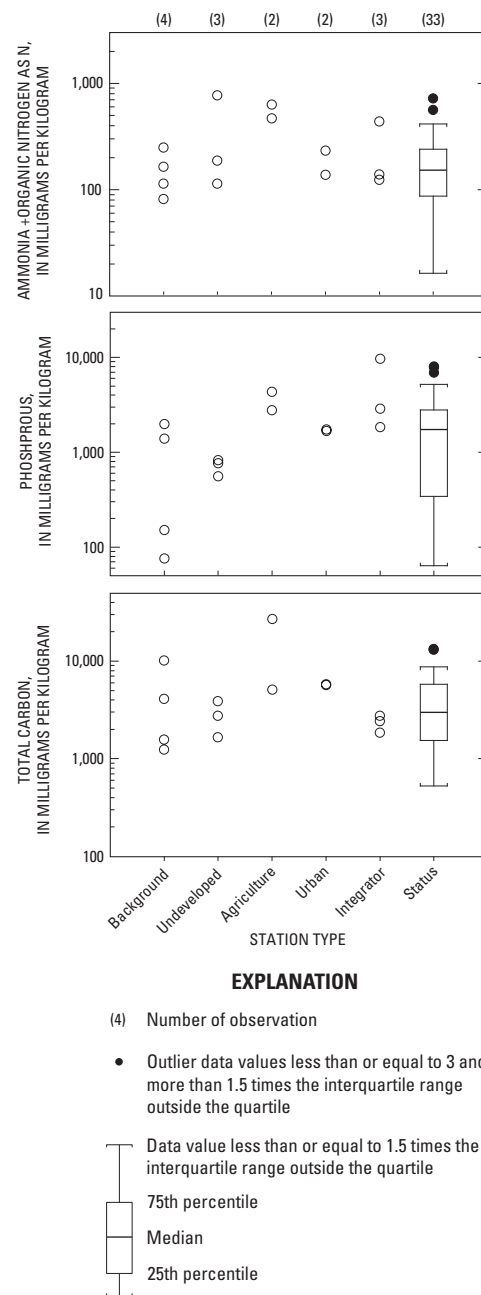


Figure 5. Concentrations of selected nutrients in bed-sediment samples from 47 stations in the Ambient Surface-Water-Quality Monitoring Network, in relation to station type, water years 2007 and 2008.

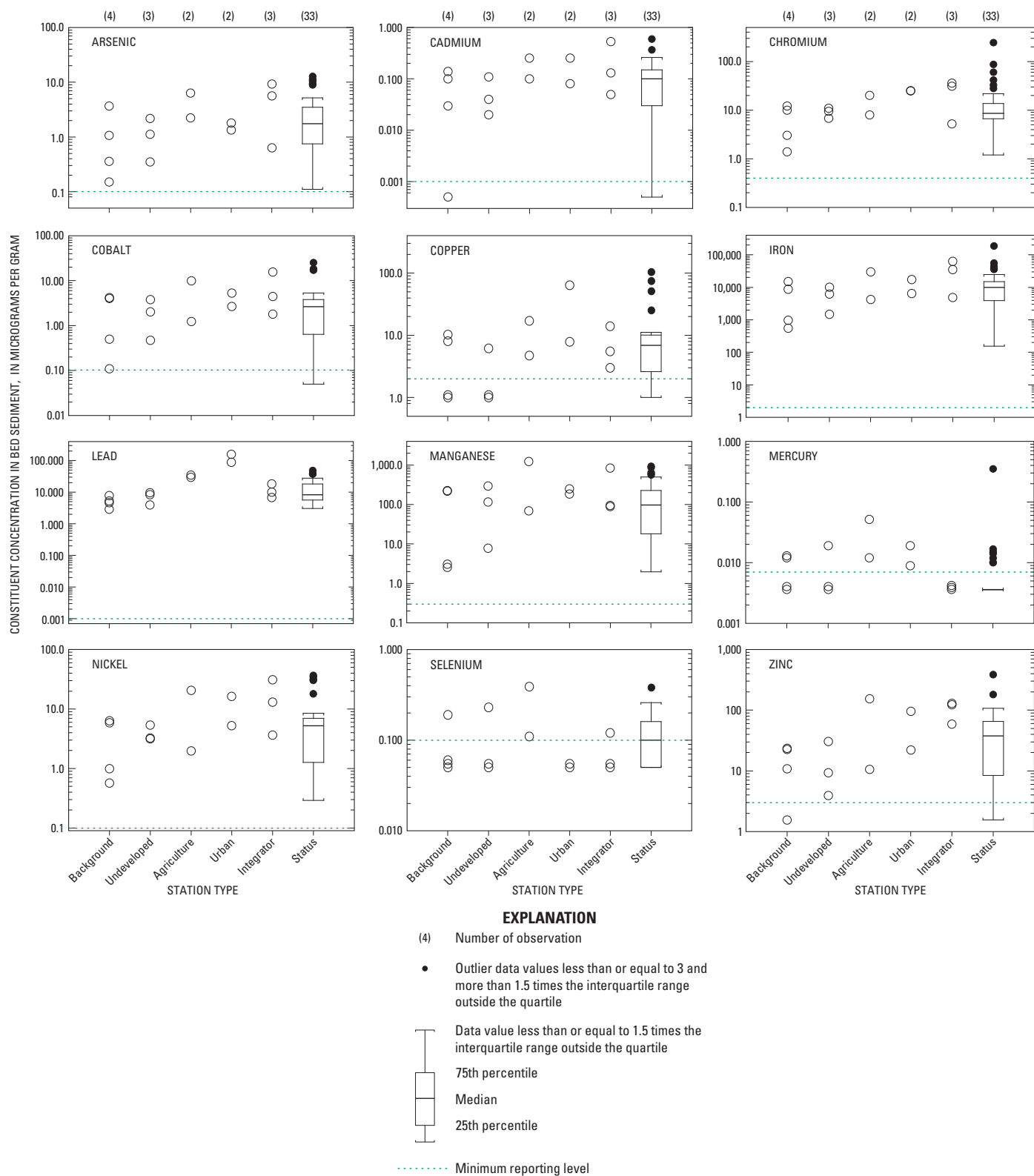


Figure 6. Concentrations of trace elements in bed-sediment samples from 47 stations in the Ambient Surface-Water-Quality Monitoring Network, in relation to station type, water years 2007 and 2008. [“Less than” values are shown as one-half the minimum reporting level.]

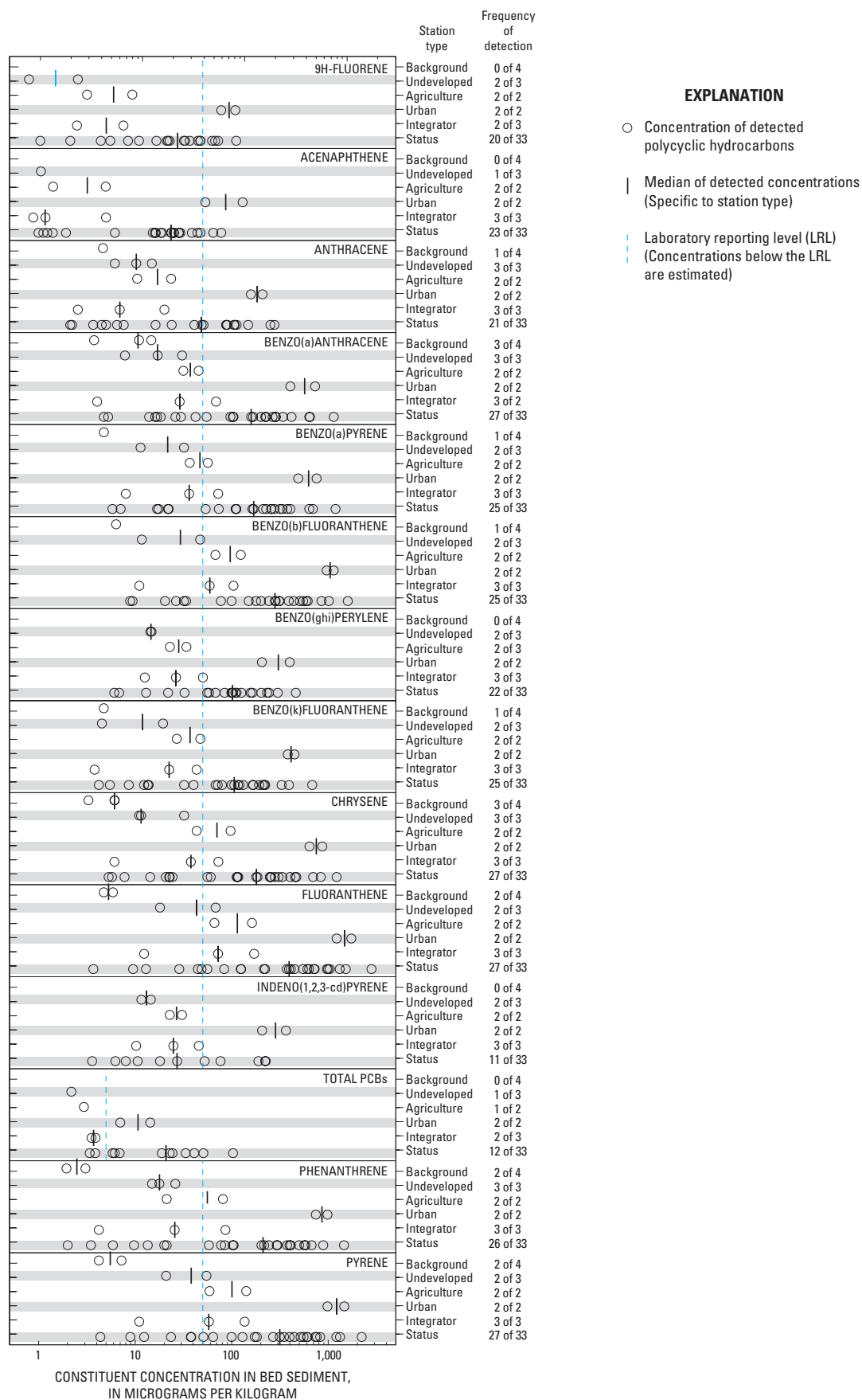
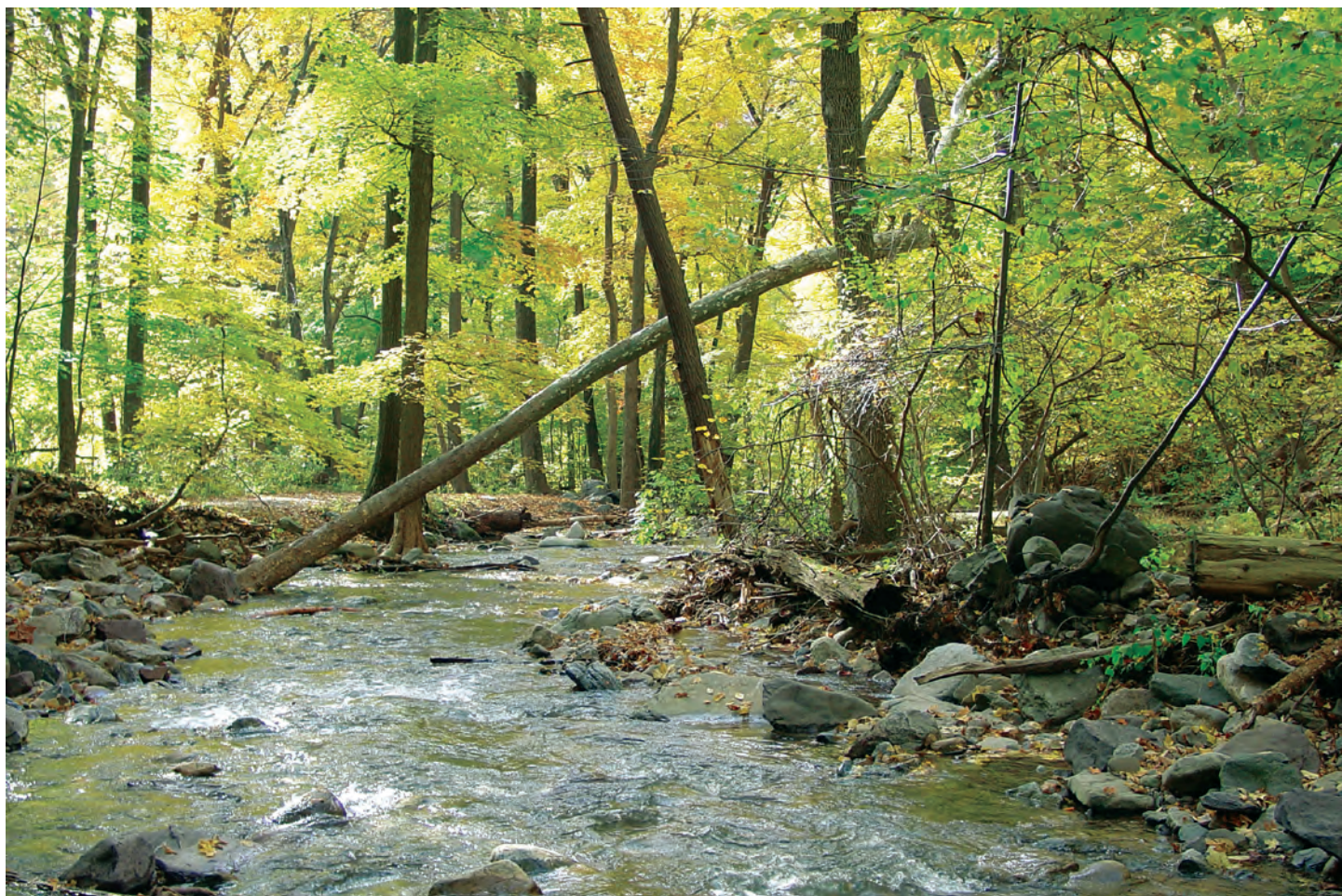


Figure 7. Concentration and detection frequency of selected polycyclic aromatic hydrocarbons detected in bed-sediment samples from 47 stations in the Ambient Surface-Water-Quality Monitoring Network, in relation to station type, water years 2007 and 2008. [Concentrations below the long-term method detection level are considered “not detected” and are excluded. Concentrations below the laboratory reporting level are estimated.]



Station 01442760, Dunnfield Creek at Dunnfield, New Jersey. Station type: Background. (File photograph, U.S. Geological Survey, West Trenton, New Jersey)

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